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Geological & Mineral Studies

IN

Copley

Nuevo Leon and Coahuila,

MEXICO.

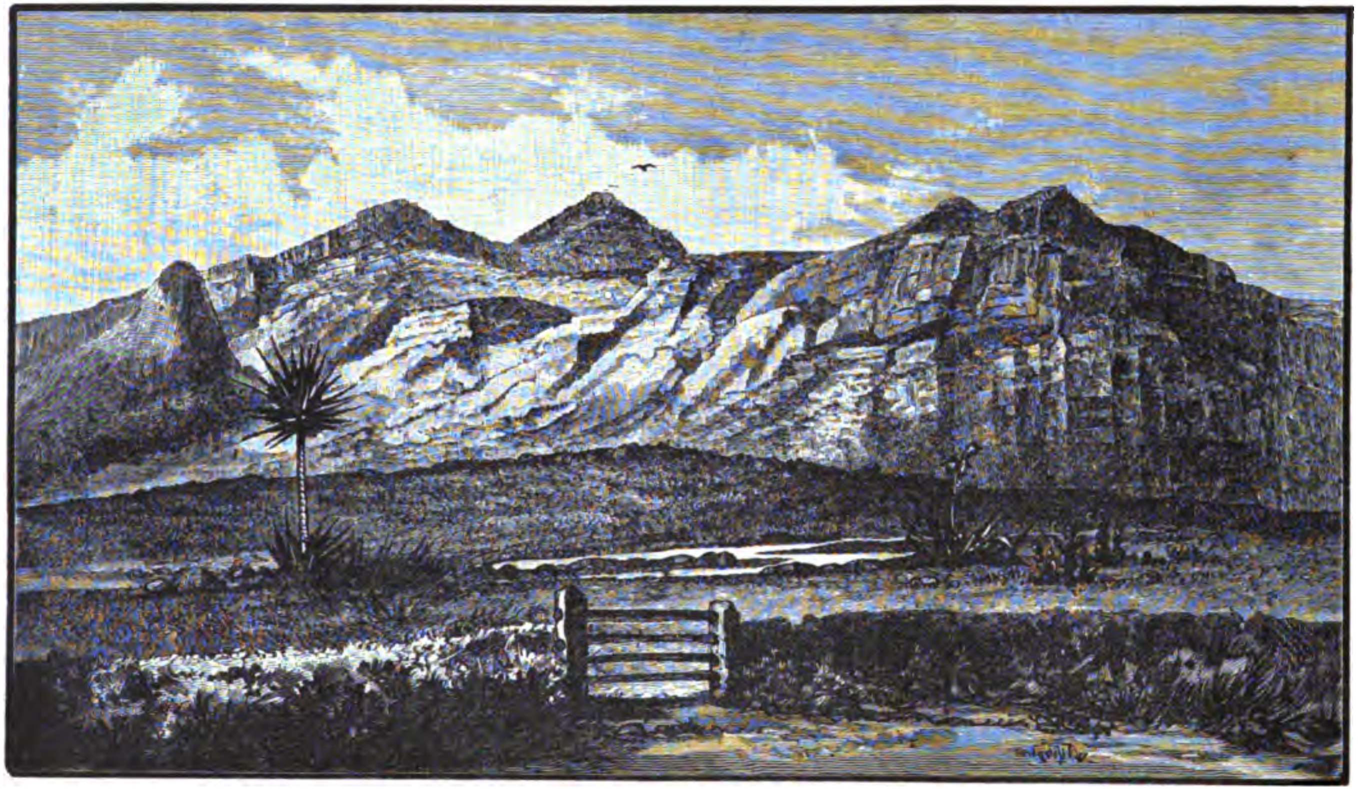
BY

DR. PERSIFOR FRAZER, S.D.

PHILADELPHIA.

A Paper Read before the American Institute of Mining Engineers, at the Cincinnati Meeting, February, 1884.

PHILADELPHIA:
SHERMAN & CO., PRINTERS.
1884.



View of the Sierra de Gomez looking southwest from the Hacienda of San Antonio. The position of the *Pinitos* mine is indicated by a round white spot in the centre background. The *Montaños* mine lies behind the central peak, vertically under the fish-hawk, and as far below the point where this line intersects the hill as the bird is above it.

~~V.1694~~
1884, May 8, By mail. Eng 1438.84.3

CERTAIN SILVER AND IRON MINES IN THE STATES OF NUEVO LEON AND COAHUILA, MEXICO.

BY DR. PERSIFOR FRAZER OF PHILADELPHIA.

The mines which I am about to describe are all situated in the northern part of the States of Nuevo Leon and Coahuila, Mexico, between the twenty-sixth and twenty-seventh degrees of latitude. They might be grouped, orographically, into four classes: 1. Those in the Sierra de la Yguana chain; 2. Those in the Sierra de Gomez chain; 3. Those in the Cerro Mercado; 4. Those in the Sierra de San Márcos chain. (See large map.)

The first two of these may be further arranged in one geographical district, to which the name, "the Villaldama district," may be applied, and the last may be ascribed to the geographical district of "Monclova."

Geologically described, the country rock, in which four of the six mines occur, is a limestone, concerning which a few words will be said further on, to wit: The "*Arroyo*" (gulch), the "*Montaños*" and the "*Pinitos*" (pines), in the Villaldama district, and "*La Paloma*" (the dove), or "*Iron Mine*," in the Monclova district.

The San Rafael appears to lie in granite, or a heavy-bedded gneiss, presenting most of the characteristics of the latter, though the contact plane of the limestone is not far off.

It is certainly worthy of attention that the ore occurs in that portion of the crystalline rock, which is nearest to the limestone, and it has been thought by some observers to be a true contact vein. It is well known that veins of this character are very often distinguished for constancy and richness. Although the undersigned cannot entirely free himself from the impression that this proximity of different formations has had an important influence in the origin of the part of the vein, on which this mine is situated; still he was unable to establish it actually *at* the contact of the limestone and granite, but rather a short distance within the latter. Two openings of the *Riojas* vein were respectively in limestone and in rotten whitish granite, but this fact, if established (as by the correspondence of the strike line of the vein in direction with that of a line joining the two openings, and the existence of an outcrop from one to the other it appeared to be), would only establish completely the independence of the fissure in which the vein was formed from this plane of contact, which it intersects obliquely.

Unfortunately, no systematic geological work has been done in Mexico, so far as the writer knows, and thus many questions, which could otherwise be at least provisionally settled by the analogies of similar occurrences in the United States, must be dealt with in another way.

The geological facts are that there is an enormously thick mass of limestone, which appears to form the greater number of mountain-chains in the district, of which I have given the boundaries, and down as far south as Monterey. On the Mexican National Railroad, just before reaching the station of Lampazos, one turns the end of the chain known as the Yguana, which extends to the river Sabinas.

This range of mountains (which has an average height above the plain of about 3000 feet, and above the sea of over 4000 feet) is composed exclusively of limestones, and throughout a great part of its extent it shows the most evident signs of metamorphism. It is most frequently of a drab or bluish-drab color; breaks with a conchoidal fracture and sharp, angular edges; contains very frequently cavities filled with crystallized, white calcite, and not unfrequently appears (*i. e.*, at *Piedras Pintas* or the "Painted Rocks") as a succession of heavy and thin, bluish and reddish layers, often weathered into the most fantastic forms (as in the cañon of the Portrero). This limestone has few of the characteristics which geologists are wont to associate with the great Lower Silurian limestone of the United States, the one particular in which it resembles and even surpasses the latter being its enormous thickness. From a few hastily-obtained, approximate data, taken in the Sierra de Gomez, near the Montaños mines, and presently to be considered, it appeared that this limestone is not less than 6000 feet, or a mile, in perpendicular thickness, and may be much more.

At present, the axes of the mountain ranges of the Sierra de la Yguana and the Sierra de Gomez are also the axes of anticlinals; the broad valley of Villaldama, therefore, representing a synclinal trough from the foot hills which lie N.E. of it to the latter range. The area between these same foot hills and the Yguana chain represents another smaller synclinal trough, and each is filled in with, probably, discordant rocks of a much later period. These are, in turn, weathered as well as strewn with debris of a quite recent origin. (See Section Plate 1.) This, then, is the structure of this portion of Nuevo Leon as well as the writer has been able to ascertain it. The essential points are: 1st. All the rocks visible across this section are calcareous. 2d. The mountain chains which bound it on either side are the oldest formations exposed to view. 3d. They cover two anticlinals, and the correspondence of the dip of the rock with the slope of the mountain sides, and of the summits with the point at which the dip changes, are very striking. 4th. This limestone is enormously thick—more than a mile—and shows signs of metamorphism in a great many places where it was examined, leading to the belief that the strata composing it were at one time subjected to high heat and great pressure while deeply buried under sediments, which were torn away at a subsequent period.

5th. These limestone mountains are intersected by a great number of veins, of which *calcite* forms the principal material, though *barite* has also been frequently observed. Numbers of these veins are barren of the precious metals, so far as is yet known, but a large number carry argentiferous galena ores mixed with zinc blende, sometimes not in paying quanties. Lead, silver and zinc may not only be said to be the chief, but the only metals present in these ores, with the exception of the usual amount of all-pervading iron.

6th. The strike of these ranges is, roughly speaking, Northwest and Southeast. To be more accurate, the Sierra de la Yguana strikes W. 20° N.-(N. 70° W.), and the Sierra de Gomez, N. 25° W. whence it is readily seen that their respective axes are oblique to each other, and would intersect if produced across the larger valley of Villaldama at an angle of 50°. (See large map.)

They are evidently two radial crumplings of the strata, and if continuous would meet near to the settlement of Pájaros Azules in Coahuila, about the N.W. extremity of the short chain called the Sierra Madre (but no part of the chains known by that name either in the United States or just west of Monterey).

One physical feature which distinguishes the mountain chains of the limestone, is their general tendency to divide into a number of precipitous belts, of which one almost always forms the capping of the range and gives it a mesa-like appearance as if a mass of molten matter had been poured out upon a level surface and had been afterwards eroded or broken down by the subsidence of the strata on which it rested.

This comparison is, however, only used in a most general way, as the columnar appearance of the narrow faces in the re-entrant angles of the mountain caps are only like the prismatic appearance of igneous rock when at a distance: on a near view these successive belts of thick limestone leave no possible doubt of their sedimentary origin, and show equally clearly that the fluted appearance is due to the general prevalence of cleavage planes, perpendicular to the surfaces of the strata. Nevertheless, the views which they present are very imposing, and together with the bold and rugged lines of the escarpment produce magnificent scenery. (See Frontispiece. See also in this connection the handsome illustrations in Emory's Mexican Boundary Survey, and the cut on the opposite page, which is from a photograph of the smelting works of the Pareña mine in the Sierra Mojàda.)

As will be found by reference to the tables of barometer levels, the Sierra de la Yguana is not so high a range as the Sierra de Gomez, or perhaps it would be more accurate to say that the portions of the two ranges which were visited differed in altitude by 2000 feet in favor of the Sierra de Gomez,* though this difference in height is not far from the correct one.

The age of this great mass of limestone is an important matter, even in an economical point of view, and great pains were taken to obtain fossils which would determine it, but the highly altered state of the limestone makes fossils very rare. Nevertheless, a few were obtained from the rocks on the slope of the Yguana chain, near to the Minas Viejas, the best of the very few specimens being found in the wall around the *jacal* (*pronounced* "*hakal*").

Prof. Angelo Heilprin, of the Academy of Natural Sciences, Philadelphia, has had the kindness to examine these specimens at my request, and informed me that there were no remains well enough preserved, to enable one to be certain of the specific name, but that in general terms all the fossils belonged to the shell family *Aviculidæ*, and probably to the genera *Pterinopecten*, *Actinoptera*, and *Leioptera*. Unfortunately these forms existed from the later Silurian, through the Devonian, and Carboniferous ages and into the Permian epoch. Prof. Heilprin, however, thinks that the fossils are more likely to be from the middle than from the extreme members of the series just named, in other words, they are Devonian or Carboniferous.

Prof. James Hall, the highest authority on the subject, was good

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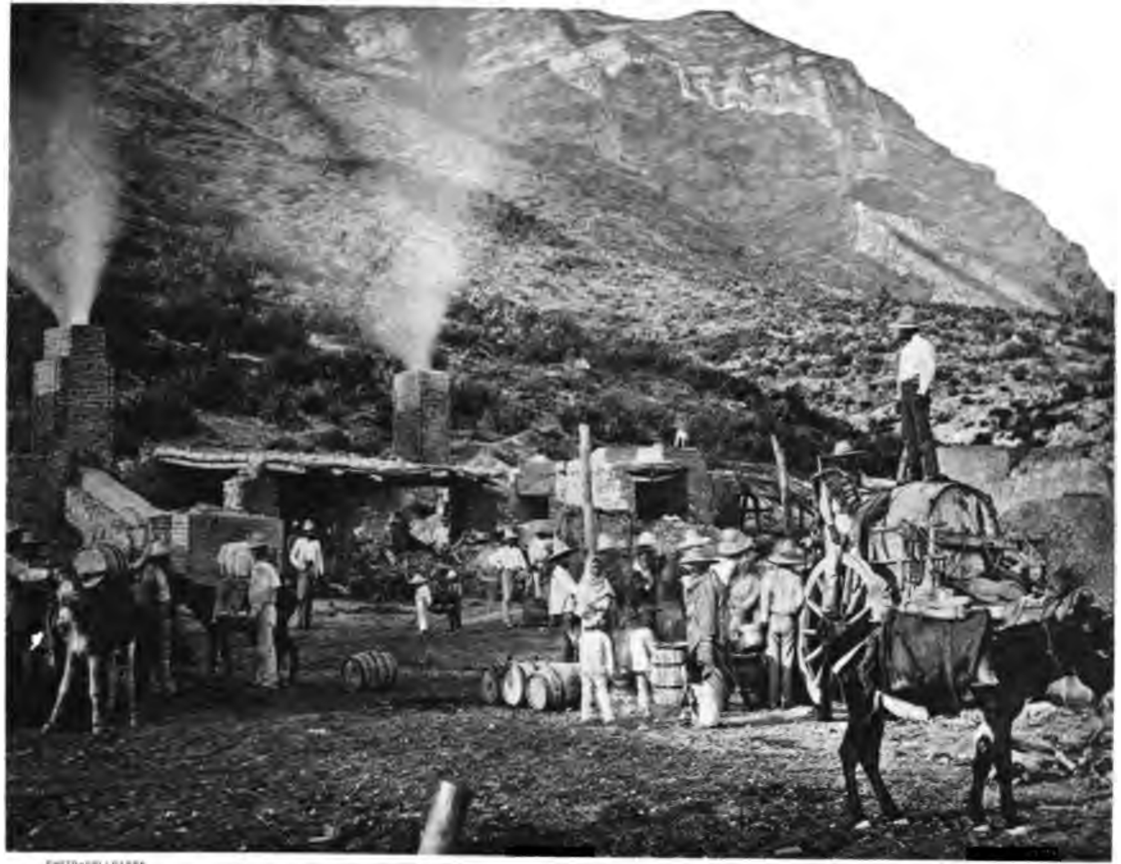
* Amidst the conflicting authorities for names of these mountains, the writer has fallen back upon the map of Nuevo Leon, published by D. Nigra de San Martin in 1853.



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SMELTING WORKS OF THE PAREÑA MINE—SIERRA MOJADA—MEXICO.

enough to send me the following statement regarding the fossiliferous limestone fragments which I sent him, taken also from Piedras Pintas and Minas Viejas.

NEW YORK STATE MUSEUM OF NATURAL HISTORY, JANUARY 16TH, 1884.

DR. PERSIFOR FRAZER,

Dear Sir . . . .

The limestone you enclosed contains two or three fossils which can be recognized generally at least. Two of these are of *terebratuloid* character, and one *pectenoid*, probably an *aviculopecten*.

I infer from the character of these organisms as well as from the physical aspect of the rock that it is of the age of the carboniferous limestone series, which is so largely developed in the southwest.

The formation is essentially an extension of the great coal measures, but mostly destitute of the carbonaceous element.

I have, somewhere in Emory's report of the Mexican Boundary Survey given my views of what I conceive to be the same limestone.* . . . .

Very truly yours,
JAMES HALL.

GUADALUPE STATION AND SMELTING WORKS.

This point, which is destined to play an important röle in the future development of Northern Mexico, is now a flourishing little hamlet, distant about a league from Villaldama, and has been reclaimed from the desert appearance which the dryness of the soil away from the streams gives to this part of Mexico, by the untiring exertion and perseverance of Mr. Casper Butcher, aided by the able assistants whom he has had the discretion to call around him. One sees for a long distance in every direction over the flat valley the chimney of the smelter and the two shingle-roofed houses which constitute the sleeping and dining departments of the settlement. In fact, from the summits of the mountains, twenty-five miles away, these buildings are the most prominent objects in the entire horizon. The description of the capacity and construction of the smelter does not enter into the purpose of this communication.

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* The observations to which Professor Hall refers will be found in Vol. I., Part 2, pp. 122–125, inclusive, of the Report of the United States and Mexican Boundary Survey. William H. Emory, Washington, 1857.

The following, relating to the limestones northwest of the Limpia range, from p. 107 of the same volume and part, by the same author, will be found very interesting:

"Although these specimens present no well-marked fossil species, I am nevertheless quite convinced, from the character of the fragments preserved, that the rock is of the age of the upper carboniferous limestone. The condition and character of the rock with the fragmentary fossils is precisely identical with specimens from the neighborhood of the Great Salt Lake, and other western localities. They contain remains of small Terebratula in like manner: and the numerous fragments of organic bodies which cover the weathered surfaces, indicate sufficiently that the rock is, in a great measure, composed of similar materials. Some of the specimens are quite compact, and others are granular in texture; they are traversed by minute veins, sometimes of calcareous spar, and sometimes of harder material," etc.

The limestone here referred to is in all probability of the same age with that forming the Yguana, Gomez and St. Márcos chains.

It will be enough, therefore, to say in this place that the smelter is designed for custom ores, *i. e.*, it is designed to take silver and lead ores of all kinds from the mines of the district, and reduce them for a stipulated price. This Fraser and Chalmers smelter is favorably located on the Villaldama river or creek (which is said never to be dry), and immediately on the Mexican National railroad, about one hundred and ten miles from Laredo, Texas, and sixty-six miles from Monterey. As a consequence of this, when the present very harassing administration* of the Mexican custom-house at Laredo, Tamaulipas, is ameliorated, as the writer is assured that it will be in a short time, machinery or materials for repairs can be telegraphed for and delivered from Laredo, Texas, at the smelter the same day. Similarly the routes for the transportation of ore from the *Arroyo* and from the *Montaños* and *Pinitos* mines are comparatively short and easy, and their carriage may be effected either in wagons or by an ore tramway as circumstances may justify.

The distance from Guadalupe Furnace, northeast to the *Arroyo* mine, is about sixteen miles in a direct line, and perhaps twenty-five miles following the direction that one is obliged to take. (See Sketch, Map No. 2.) The first two and a half or three miles to the low foot hills is a gentle ascent of only 225 feet which is hardly increased in the succeeding seven or eight miles to Piedras Pintas where the foot hills of the Yguana are first encountered. The entire distance up to this point is over a very gently undulating plain teeming with Nopal, Maguey, Lechugilla, and interspersed plentifully with the Palma Real. A road can be made in almost any direction over this plain, which is free from deep arroyos or acequias.† Even for the five miles or so which are traversed from the Piedras Pintas to the foot of the steep ascent of the main range, the rise is only 1500 feet or about 300 feet to the mile; which permits of an inexpensive road, being made to carry heavy ore carts, or of a mining tramway. An additional facility for the construction of either is found in the very numerous boulders and pebbles of hard limestone which are found in the bed of the gulch which leads up from Piedras Pintas between two spurs to the main chain of the Yguana. These permit repairs, filling, and embankment to be done with less cost than if the materials for such structures were only obtainable from a distance, or the rock massive.

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* December, 1883.

† Ravines or irrigating ditches.

Here, probably, the main road (if the transportation were by team to the Guadalupe Furnace) should terminate, although there would be no difficulty, except the expense, in the way of constructing a road either for wagons or tram-cars to the summit of the range. Questions of this kind cannot be definitely determined until the mines, on account of which they arise, have been more fully developed. From the head of the gulch the ascent is rapid to a certain cedar-tree on the western flank of the mountain which marks the junction of the trails to the mines from Guadalupe station or Villaldama, and from Candela. This cedar-tree is assumed in the absence of accurate data as about 1225 feet above the Piedras Pintas, or the mouth of the gulch between the spurs of the Yguana range. The altitude of this horizon above the sea is 3212 feet by uncorrected aneroid barometer, or 600 feet above the foot of the steep ascent. The rise from here to the crest of the range by zig-zag road is 1250 feet, this elevation being by the same instrument (and subject to the same errors) 4462 feet above sea level. As may be seen in this same very rough sketch the "Old Mines" or *Minas Viejas* now belonging to and owned by the Guadalupe Company lie beyond or east of the summit and about 400 feet below it in altitude. The *Arroyo* mine lies about northwest from the jacal or walled domicile built for the accommodation of the workers of these mines, and is distant somewhere between three and four miles.*

Following a mountain trail from this jacal along the slope of the main range, and afterwards over one of the numerous spurs which jut out at irregular intervals on each side, one comes to a group of three mines situated on a vein (which is also said to be the same as that of *Minas Viejas*), belonging to the Guadalupe Company, and called the "*Buena Vista*," the "*Doctor*," and the "*Guadalupe*." The openings are passed in descending the steep sides of the gulch in the order just given, and by barometer they were respectively 3897, 3797, and 3517† feet.

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* It is to be observed that the distances everywhere in this paper, except where it is specially mentioned, have been obtained by guessing.

† This level was taken on the return from the *Arroyo* mine. But just before taking the reading at the "*Doctor*," the barometer indicated a jump of 75 feet, and of course this correction was made.

The *Arroyo* is situated on the opposite side of the gulch and near the extremity of the spur into which it is driven. Its mouth has an elevation of 3230 feet above the sea or 250 feet below the last mentioned of the above group of three mines.

"ARROYO."*

The entrance to this mine is an inclined drift, some eight or ten feet above the trail, by which it is reached, and from which access is had by the usual Mexican ladder, a notched tree-trunk.

The indications of a vein here are distinct enough, but, unlike the *Buena Vista* and the "*Boca Negra*" of the *Minas Viejas* group, the gangue is not calcite, and differs only in some characters from the surrounding limestone, which forms the country rock. What appears to be a cross-cut has been driven through barren limestone, until the vein was entered and the drift, changing its direction, in conformity with the latter, has penetrated, up to the present time, about ninety feet across the nose of the hill. The direction of the "*Doctor*" dump from the mouth of the *Arroyo* was, by prismatic compass, N. 38° W.; but this observation was necessarily a rough one on account of the great difference in level between the two points, which rendered it impossible for the eye to view the dump and the compass card at the same time. Moreover, the exact location of the dump from the mouth of the "*Doctor*" opening was not taken.

The dip of the vein in the *Arroyo* was about N. E.—65°, which would make it strike N. 45° W.; differing, therefore, 7° from the line joining the "*Doctor*" and the "*Arroyo*." Nevertheless, on account of the prominence of the vein, and the frequently observed wavy strike-lines of the veins in this and other regions, it is thought most probable that both mines are on the same vein. After a slope of about ten feet in length through red dirt, a shaft of about ten varas† reaches the bottom of the excavation, and exposes a vein six feet in width.

This vein-matter is mainly a ferruginous limestone, but, like all the veins which the writer examined in the range, is destitute of well-developed walls. There seems to be an insensible transition from the barren, hardened limestone of the mountain to the reddish and often pulverulent material which constitutes the vein.

Between the walls of the vein and on the lower face are two

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* See Plate 3.

† The Mexican vara is equal to a length of 33.38 inches. Accurately 0.84796 meter.

"horses" of barren limestone, which together make up about one-half of its entire breadth, or three feet. A careful section was made of the entire working face, including the horses, by knocking off specimens from every part of an imaginary line crossing it. This contained (as was feared) but a trace of silver, and very little lead.

The head-miner of the Guadalupe Company selected from the pay-dirt in this mine a specimen for analysis, and the assay of this sample in my laboratory was: Silver—$19.35; lead—$18.54; total—$37.89 per ton.

Nos. 3 and 4 were given to the writer by Mr. W. A. Butcher,—(see page table of analyses on page 28) as samples of the ore of this mine; but it is not known from what part of the mine they were respectively taken, how they were selected, nor who selected them.*

No. 5 is an assay of a sample taken by the writer at random, from the dump of red ore in front of the opening to the *Buena Vista* mine, and analyzed for comparison with the ore of the *Arroyo*.

Making what allowance could be made for the angle in the drift, the average line of opening in the *Arroyo*, from the extremity of the drift to its mouth, is S. 42° E., which agrees within 4° of the direction of the Guadalupe mines, on the opposite side of the arroyo and 3° of the approximate strike of the vein given above.

SPECULATION AS TO THE MINE'S HISTORY.

The mine has doubtless been opened, and, in all probability, worked profitably for a time. Afterwards, it is likely that the pay-streak pinched, or that the vein became poor in the direction in which the drift was being pushed. The miners then came back from the extremity of the drift and sank the shallow shaft to which reference was made above. There are some signs remaining that this was also profitable for a time, but the bottom again approached the barren zone, which had been found above, and from some cause the work then was stopped, or, perhaps, the small excavations, oblique to the main drift, were made in the effort to find the lost "pay." Whether or not this purely conjectural version of the history of the mine be the real one, there is no doubt that the work was left where the ore failed, or was, at best, very lean, and years of neglect were allowed to add to this unfavorable appearance of things by the disintegration of the walls and breast and the gradual accumulation of debris. In this state it was examined.

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* The analyses of various samples given to me by different persons as coming from the mines will be found in the table, along with those taken by myself.

The vein of the *Arroyo* is most probably the same as that which is now worked in the "*Doctor*," the "*Buena Vista*," and the "*Guadalupe*" drifts, above described, not to speak of the *Minas Viejas*, which are too far off to permit this statement without some necessary preliminary topographical work. But if not on the same vein as that of the latter, it is clearly an allied vein in the same mineral zone, and most probably connected with it both genetically and actually. The vein is wide (for the veins of this region), and as well defined as most of them, though it lacks the customary calcite gangue. It is well located for getting out what is found in the extremity of the space which it traverses, and would soon open 100 feet or more of stoping ground if properly exploited. It lacks the thick cover of the mines on the other side of the gulch, but contains enough to be worked actively to advantage when pay-ore is again found and followed.

PROBLEM OF DRESSING ORES IN ABSENCE OF WATER.

Two questions arise in connection with this mine which are of immediate importance. These are: 1st. The means of concentration; and 2d. the means of transportation. As to the first, it will be necessary to perform this, if possible, as near to the mouth of the mine as possible, in order to avoid the useless expense of a difficult transportation of worthless rock. But there is no water which may be depended upon for wet concentration. In revenge for the soft rock which can be cut for one-half, or less, what granite costs, the absence of water from this whole region is at once its chief characteristic and the greatest obstacle to its improvement. There is but one solution to the difficulty, and that is some form of dry concentration similar to that known as Paddock's.

This machine is well adapted to the work it will have to do here, viz., the separation of limestone and zinciferous galena, provided that a motor can be found. It is possible (not very likely it must be said) that somewhere in these foot-hills water could be got by artesian borings. If not, the water for a steam-engine would have to be hauled, and it would become a question of vital interest to know whether windmills, caloric engines, or the as yet visionary sun-engine of the great Ericsson, could not be employed here and in similar cases.

TRANSPORTATION.

As to the transportation, it will appear from the preceding remarks that the plan which in all probability will be found the best for transporting the *Arroyo* ores to the Guadalupe furnace is by wire tramway from the mouth of the mine to the summit of the Yguana range, and thence either by a continuation of the same means to a point where the cart road from the Guadalupe furnace reaches the mountain: or, it may be found feasible and convenient to transport the ore through a chute by its own gravity, from the summit to a pocket at the terminus of this cart-road, in which case so much power will be saved. The same remarks as to power which were made just now in connection with the concentrator and crusher apply equally to the wire tramway.

THE MONTAÑOS AND PINITOS MINES*

Are situated respectively on the east and west slope of the Sierra de Gomez, and are reached by a comparatively level road from Villaldama southwest across the valley designated by that name to Portrero, and thence by trail for about 15 miles from the ridge to the mine. The grade from Villaldama to Portrero is very slight, the latter place being distant about eight miles, and lying at an altitude of only 75 feet above the former. The Hacienda de San Isidro del Portrero, as this flourishing little hamlet is called, forms a borough governed by an Alcalde, Juzgado, etc. The highly cultivated fields immediately around it are watered by the Portrero stream, which descends the mountain from the Hacienda of San Antonio, shortly to be mentioned. At the time of the writer's visit, December 1st and 2d, 1883, the sugar-cane was luxuriant and ripe, as well as the Maguey de Castilla, and many domestic plants. This fertility is an important factor in the problem of any future industry undertaken on the large scale, because it shows what the country could be made with intelligent tillage and irrigation. There is nothing in the soil underlying this settlement which gives it an advantage over the broad plains which stretch between these mountain ranges from Lampazos to Monterey, except what is gained from the water of the brook which bears its name, and the cultivation which this accidental advantage has invited. But the gardens bloom with all the ornamental and useful plants of this semi-tropical climate, and it would doubtless be easy to prove, statistically, that the hacienda as a farm has always been a commercial success.

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* See Frontispiece.

A short ride across the valley southwest, brings us to the mouth of the Portrero stream, at a height of 1917 feet, while the town of Portrero is 1822 above sea-level. The road up this cañon is strikingly beautiful, winding among the sharp cliffs weathered into the most fantastic shapes which crown the stream. This last is collected into an artificial channel and directed by advantageous cuts from side to side across the little valley. A merely rough guess makes the Hacienda of San Antonio about eight miles from that of Portrero. Here is the site of a small Mexican smelting furnace, or "Horno," which, together with a crude apparatus for washing the ore, has been in use by the owner, Don Tomas Gonzalez Villareal, for the treatment of the Pinitos and Montaños ores. A plan of these works (Plate 4), together with the washing pit, ditches, and stream outside of them, will be found at the end of this paper.

As will be seen, one end of the hut is taken up by the furnace, which is made by simply partitioning off a length equal to the desired width of the furnace. The in-walls are then obtained by adding refractory materials to the inside, and a tuyere-hole produced by cutting a hole in the partition. There is no chimney proper at present, and the fumes of the furnace probably found their way to the upper air with considerable irregularity.*

A rude waterwheel of the turbine family was so connected with a crank as to work a roughly constructed bellows which assisted the smelting.

The capacity of the "Horno" is said to have been from 1½ to 2 tons per day, which is a fairly creditable practice for such an apparatus.

The stream which waters the hacienda, proceeds from three springs, distant about half a mile across a growth of low Palmas Reales, and pine trees. These springs are evidently not true springs but are most probably small streams which plunge into a mountain cavern some distance up the side of the mountain, and continuing subterraneously, issue at the place named. Their temperature is quite high, and almost immediately after their appearance, they form a volume of water equal to 1994 gallons per minute which flows past the works.† The declivity of the hill east of the jacal and ore-house, is very steep, or about 25 feet in the first 100 yards to the east, or 80 feet from the works to the foot of the hill, distant perhaps twice as far. There is, therefore, evidently fall enough to use economically the power of this stream in a turbine wheel; though whether this would be a sufficient motor depends upon the amount of work required of it. It would not suffice for this purpose if the production of the *Montaños* and *Pinitos* mines should become large, and the water to wash the ores as well as the power to drive the machinery by water wheel were sought in this stream; but it would amply supply all the water necessary for steam boiler purposes, as well as that for the concentrators.

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* For a description of the structure and duty of this kind of a furnace, see paper by W. Lawrence Austin, Phila., in the Transactions of the Am. Inst. of Min. Engs., vol. xi., p. 91.

† This estimate is based on the average of a few experiments with floats. The distances were obtained by pacing, and the cross-section of the flowing water by means of a foot-rule.

At this place there is a tree of the species known as the Nogal (or walnut), very remarkable for its size, more especially so in the absence from these mountains, of large timber suitable for heavy mine timbering purposes. This tree measured 10 feet 6½ inches around the trunk, at a distance of five feet six inches from the ground.

The trees of this region are larger and more numerous than those observed elsewhere, but there are few suitable to the strain of supporting the roof of a flat vein.

From the southwest side of the Horno of Don Tomas Villareal, called San Antonio, one has a fine view of the mountains, and of the mouth of the *Pinitos* mine. The *Montaños* is hidden behind the highest as well as the most remote of the peaks in this part of the chain. (See frontispiece.) The position of the *Pinitos* is marked by a round white spot; that of the *Montaños* is as far below the point of intersection of a vertical line from the fish-hawk with the slope of the hill, as the bird is above this point.

The distance in a straight line from San Antonio to the *Pinitos*, is about one and a quarter to one and a half miles, and the elevation of the latter above it is about 2567 feet. The country immediately in front of the hacienda, and between it and the mountains is a basin filled with rounded hills of comparatively moderate height.

The elevation of the *Pinitos* above the Horno is so considerable that there is no difficulty in solving the problem of getting the ore down to the latter. A single chute would probably suffice to effect this to the base of the hill, after which a wire tramway or other mode of conveyance would be needed to carry the ore to the works of San Antonio. The *Montaños* mine is at a considerable distance from the *Pinitos*, and over the divide. In order, therefore, to transport its ores as well, it would be necessary to carry them up a grade of 555 feet before they commenced the descent of 3820 feet, which separates the San Antonio works from the summit to be crossed, and some method of continuous transportation from the *Montaños*, to the *Pinitos*, would probably be found desirable.

"PINITOS,"

is situated on one of the high slopes of the eastern part of the Gomez range, and, as before stated, about 1½ to 2 miles from the Horno of San Antonio, in a straight line. There are two principal openings to the *Pinitos*, the regular and larger opening lying to the north of the other, which is newer.

This latter or southern opening is narrow and irregular (as are most of the openings to Mexican mines), and it runs back about E. 20° N. (neglecting the angles) for 80 feet.

The vein here, as has been noted elsewhere, is not like those fissure veins, of which the walls are defined, and mark the boundary between different rocks. Here the country rock as well as the vein are limestone, but in the latter the limestone is stained with iron oxides, and is less hard and compact. The opening is about 5 feet high, and 4 feet wide. Don Tomas Villareal supposed that the entire vein contained ore. A great deal of calcite occurs here in the form of patches and strings, but not to the extent of filling the vein. According to the statement of the owner, Don Tomas Gonzalez Villareal, the ore from the working face of this mine has assayed 18 marcos per carga. [A marco equals about 8 ounces, and a carga 300 pounds. This would equal about $1238 per ton of 2000 lbs.].

The present working face of the southern opening reveals a crevice, which contains no visible ores in sight, though occasional patches of calcite of higher specific gravity than usual are found on the walls. An average of the gangue mass at the extremity of this drift was taken, and proved to contain 1 ounce of silver ($1.29) to the ton.

A pocket has been dug out on the side of the trail, and adjoining the drift to the south. The ore exposed consists of red and yellow clays of high specific gravity, with an apparent dip of W 10° S–15°.

The main or northerly opening of the *Pinitos* exposes the vein more perfectly, with an average thickness of about 1 foot, and an average dip of ± N. 20° W. — 45°.

The vein matter consists of calcite stained by oxide of iron, and holding minute crystals of lead minerals, which give it a higher specific gravity. This iron-stained gangue can be followed on either side for some distance, and several smaller veins or feeders can be observed to join it, but these latter are to all appearance barren; or at least the minerals, which they possibly contain, are not in large quantity, and are masked by the material of the gangue.

In order to secure a good average sample of this ore, specimens were taken from all parts of the vein exposed, and they may be considered a fair exhibit of what the mine will produce in its present condition: The assay gave silver, 24 ounces; lead, 21.9 per. cent.; total value of ore per ton, $50.01.

The "cover" on the Pinitos is ample, and the facilities for extracting the ore, and transporting it to the works at San Antonio could hardly be conceived better than they are. The ore also is less adulterated with zinc blende than the ores of the Sierra de la Yguana.

"MONTAÑOS,"*

is situated, as stated before, on the westerly slope of the Sierra de Gomez, about four miles westerly from the *Pinitos*, and 550 feet below the summit. Between these two latter a number of veins are visible; one in particular, 7 feet wide, and striking northwest on the bold face of a cliff at the angle of one of the numerous turns which the trail makes over the mountain, was said not to have been "denounced"† on account of its barrenness. Another vein of this colored calcite, still nearer the *Montaños* property, strikes N. 20° W., and is about 5 feet in width. This latter coincided very nearly with the apex of the anticlinal of the mountain, or the point where the general dip of E. or N.E., which had characterized the exposures heretofore, was exchanged for one of W. to S.W. (in point of fact, S. 20° W.), and the massive limestone commences to descend into the western plain in the same manner, as on the eastern side, into the valley of the Villaldama.

The apparent analogy between the two valleys is even carried further by a series of low hills which occur in a position with regard to the great chains similar to those east of Guadalupe station. On the actual summit of the mountain anticlinal, the dip is S. 30° W–18°.

But the little ridge in the middle of this western valley appears not to be an anticlinal but a monoclinal, conformable with and above this limb of the west dipping mountains. In this case the thickness of the limestone from the face exposed at the crest to the lowest face which dips into the plain is not less than 6000 feet, and the actual thickness of the formation is much more.

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* See Plate 5.

† That is, staked out and recorded.

The "*Montaños*" mine seems to have been opened at the junction of two larger and several minor veins. The principal opening is on the edge of a nose of the mountain which, stretching out to the south, forms a very steep declivity on all sides but one, and the western boundary of a deep ravine. The first noticeable vein here, dips about E. 35° N.—85°, and can be traced for some distance down the mountain side. The walls of this vein are, like those previously mentioned, ill-defined. At the main entrance the ore-bearing zone is very much enlarged, owing to an intersection of this with another vein, which is nearly flat. This great enlargement of the outcrops and the abundance of galena and "pay dirt" everywhere in sight, have combined to instigate a very complete exploitation of the mine, whence large quantities of lead and silver have been obtained.

On entering the mine the eye is instantly arrested by the confusing appearance due to three larger, and numerous other smaller strings, and leaders which render it difficult to comprehend at the first glance their true relations to each other.

Openings of various magnitudes have been made on the flat vein at several points around its periphery, and at the point near the boundary line of the property which is given in the accompanying sketch. A good exposure of this vein gives a dip of W. 20° N.—15° to 20°. (See plan.)

A newer opening than that first mentioned was called the "Boca Nueva" by a miner. Here the dip in the flat vein is W. 30° N. It is thus seen that two principal veins dipping nearly at right angles to each other intersect at this point and increase very much the richness of the ore. The steep dipping vein has not been very extensively explored, but the other has been worked throughout a great part of the area included between the boundary line above given and the sides of the steep hill. It may be due to this fact that the *Montaños* mine is known in the region as a low grade, while the *Pinitos* has the reputation of a high grade silver-lead mine; because, whatever be the reason, the highly inclined veins of this district, which belong to a different system of fissures and most probably to a different epoch, have been observed by the writer to carry, as a general rule, larger percentages of silver than the veins of low inclination.

In the mine, pillars are everywhere observable in which the ore, which is from eight inches to two feet in thickness (and exceptionally much larger), can be followed from one mouth to another. Specimens from a large number of exposures of this kind were carefully collected and averaged, and gave values of $10.32 of silver, and of $46.88 of lead per ton; making a total of $57.20 per ton.

The ore of the Boca Nueva above similarly sampled, gave $5.81 in silver and $44.27 lead, or a grand total of $50.08 per ton.

Most of this ore is in a ferruginous mass of impure carbonate of lime, but the richest of it is associated with a very white calcite which generally accompanies the latter as a superior or inferior layer; but is sometimes in it, and sometimes away from it altogether.

Allowing the thickness of the pay streak to be only 1 foot, at the assay value of the average from various places in the mine ($57.20) there is a value in sight from the flat vein alone, of $400,400. In this the vein of high inclination is not calculated at all.

The specific gravity of the average *Montaños* ore is about 4.52.

THE MONCLOVA DISTRICT.

The Monclova district lies about eighty miles W. N. W. of Villadama, and somewhat less from the town of Lampazos, which was my point of departure from the Mexican National R. R. The ride from this town is about twenty miles S. W., to Candela, at the foot of the picturesque mountain of that name. Thence through several *Puertos* or passes one travels westward across the plain which separates the Sierra called "Madre" (like so many others), with its outlying peaks like "la Rata," etc., on the north from the Sierra de la Gloria on the south. Rounding the northern end of this latter one soon arrives at Monclova, a well-watered, quaint, and most interesting old Mexican town. It is distinguished alike for the green foliage and verdure which form a relief to the eye after days spent in these arid valleys, and for the exceptional picturesqueness of its old churches and streets, the latter unusually busy for the region.

"LA PALOMA."

The iron-ore mine called thus is situated about seven miles southwest of the town of Monclova, the flourishing settlement on the stream of the same name in the northern part of the State of Coahuila, which has just been mentioned. The railroad from Eagle Pass is now finished to this town, and passes within two miles of the mine. The chain of mountains, on a spur of which this mine is situated, is called the "Cerro Mercado;" and the country rock, like that of the mines hitherto considered, is a massive limestone.

Monclova is, by uncorrected barometer, but 1937 feet above the sea,* and the mouth of the pit at the La Paloma 2577 feet. It is, therefore, 640 feet above the general level of the plain, which extends to the south from Monclova, between this range and that of the Sierra de la Gloria, for about twenty-two miles to the Sierra San Márcos.

The mine is an immense deposit of iron ore and pyrites in a thick mass in limestone, The dip in the pit (which is ten varas deep) is N. 30° E. + 70°.

At the bottom, a layer of this pyrite, of about eighteen inches in thickness, covers a heavy mass of mixed hematite and magnetite.

The dip of the limestone of the south base of the foot-hills is about N. 30° E.—20° ; but some large masses near the mine, which seemed to be in place, gave S. 40° W.—75° ; so that the strikes of the limestone and of the ore nearly agree, and the latter has been probably deposited in one of the joints or cleavage planes of the latter, though it is possible that the spur itself may be anticlinal, and the iron ore deposit a true bed-vein. In either case there is the clearest evidence that the iron ore is an alteration product of the pyrite, but so complete has been the alteration that a few inches above the line of demarcation, between the sulphide and the oxide of iron, hardly a trace of the sulphur remains. The outcrop of this vein has been broken into large and small fragments, and it has been scattered over the side of the steep hill, which borders a very deep gulch or ravine leading directly down into the plain and to the railroad. It is difficult to estimate the amount of this sliding outcrop, but thousands of tons of a very fine quality of iron ore are here ready to be loaded and transported to the market, while the amount in the ground capable of easy mining is enormous.

It was very difficult to ascertain the thickness of this bed-vein, on account of the heavy debris and detached ore, which cover the surface from the mine-mouth to the bottom of the gulch; but, assuming a ridge of limestone which crops out about 25 feet below the pit, as one boundary, and the limestone exposed in the opening as another, there would be a thickness of 80 feet of ore and pyrite mixed with " horses " of the country rock.

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* A note from Mr. E. A. Handy, engineer in charge of the Mexican National Construction Company, gives the correct level of Monclova as 1980 feet, but as the point is not specified, I have left the barometer level as I obtained it.

In order to test the value of this ore severely, a sample was taken by the writer across the face exposed in the pit, inclusive of a horse of limestone there visible and some scattered masses of sandy material. It is needless to say that all these impurities would have been discarded by the roughest system of mining, and the average percentage of the iron would have been correspondingly raised, yet, even this sample gave 53.80 per cent. of metallic iron, a result about equal to the average of the product of certain James River ores.*

The following are the results of a chemical examination of the two classes of ore, *i. e.*, A, a large sample of the ore taken across the present exposed face in the pit; and B, a large sample of the float ore in the vicinity of the mine.

The complete analyses of these two samples (A 1 and B 1) were made by the writer's assistant, Mr. Richard D. Baker. Independent determinations of the more important constituents (A 2 and B 2) were made by his assistant, Mr. C. Hanford Henderson. Both samples were taken by the writer himself.

The column X contains Mr. Henderson's determinations of a sample of the ore furnished by Mr. W. A. Butcher.

The specific gravity of A 2 was 3.9.

	A.		B.		X.
	1 p. c.	2 p. c.	1 p. c.	2 p. c.	p. c.
Insoluble residue,	11.860	....	2.880	....	....
Ferrous oxide (FeO),	16.015	....	14.469	....	....
Iron sesquioxide (Fe_2O_3)	59.244	....	73.365	....	....
Alumina (Al_2O_3),	6.976	....	6.315	....	....
Lime (CaO).	1.320	....	1.580	....	....
Magnesia (MgO),	trace	...	trace	....	....
Sulphur (S),	3.726	4.510	1.555	1.504	0.610
Phosphoric oxide (P_2O_5)	trace	trace	none	none	0.107
Sum,	99.141		100.164		
Metallic iron,	53.93	53.86	62.60	61.71	61.56
Phosphorus,	trace	trace	none	none	.047
Silica,	....	10.04	....	2.88	6.14

It will be interesting to compare these results with the appended averages of the best mines of the Marquette and Menominee districts in Michigan.

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* See the ores of the Middle James River, by the undersigned. Read before the American Institute of Mining Engineers, at the Virginia meeting, 1881.

This ore, as will be seen, is remarkably pure and rich, and suitable for the manufacture of steel. It would be of great value as a mixture with cold short ores, and would pay for a long and expensive transportation.

The following table will exhibit at a glance the comparative values of this ore; the Durango ore, collected by Mr. John Birkinbine, and analyzed by Mr. A. S. McCreath, chemist of the Second Geological Survey of Pennsylvania; the ores of the Middle James River, which were carefully studied by the writer in 1880–81; the celebrated Menominee and Marquette ores of Lake Superior separately; and finally, the average of all the Lake Superior ores taken together. The column of values, at the foot of the table, is calculated on the basis of nine cents per unit of iron, which is the price given by Mr. Francis Wister for foreign iron-ores at this date, January, 1884, It should be observed that high-class Bessemer ores are restricted to less than 0.05 of phosphorus, and those containing more than that are not received.

Pl. av. is the average of the two analyses, A 1 and B 1.

Pl. crop. is the average of the two analyses, B 1 and B 2.

D. 27. is the analysis of an average of twenty-seven samples of ore from near Durango, in the Cerro del Mercado,* taken by Mr. John Birkinbine.

D. 4. is the analysis of the average of four selected samples of the above.

J. is the average of eighty-two analyses for iron, seventy-two for phosphorus, and twenty-two for silica, of the ores of the Middle James River, Virginia.

Mnee. is the average of forty-eight determinations of iron, forty-five of phosphorus, and twenty-five of silica, of the ores of the Menominee iron range, Michigan.

Mqt. is the average of eight determinations of iron, eight of phosphorus, and eight of silica, of the Marquette region, Michigan.

S. is the average of fifty-six determinations of iron, fifty-three of phosphorus, and thirty-three of silica, of Menominee and Marquette iron ores of Lake Superior.

V. is a calculation of the value of ores at the rate of nine cents per unit (omitting all those containing over 0.05 per cent. phosphorus).

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* It is perhaps needless to remark that the "Cerro del Mercado" of Mr. Birkinbine's report, is about 250 miles Southwest of the Cerro Mercado spoken of here.

	P.c. Pl. av.	P.c. Pl. crop.	P.c. D 27*	P.c. D 4*	P.c. J*	P.c. Mnee	P.c. Mqt*	P.c. S
Metallic iron, . .	53.89	62.15	55.80	62.77	48.68	62.88	66.01	63.33
Phosphorus, . . .	trace	trace	1.328	0.288	0.07	0.023	0.063	0.0293
Sulphur, ...	4.12	1.530	0.085	. . .	. . .	. . .	. . .	. . .
Silica, ...	10.04	2.88	7.760	5.240	23.98	4.49	2.22	3.40
Value per ton, . .	4.84	5.55				5.66		5.70

In this connection the information contributed by the report of Mr. John Birkinbine, Secretary of the United States Association of Charcoal Iron Workers, is interesting. In the report, from which the extracts of analysis in the above table are taken (D 27 and D 4), Mr. Birkinbine says of the Durango iron ore deposit:

"A deposit which covers so great an area as 10,000,000 square feet, and yields an average of 55.8 per cent. metallic iron from samples containing considerable foreign matter, fairly representing the average of the ore, is unusual; and samples from an area of fully 7,000,000 square feet, which analyze nearly 63 per cent. of iron, demonstrate the value of the deposit. The only constituent of the ore which shows to a possible disadvantage is the phosphorus; this is not excessive,† and, by the application of the basic lining, could be used to produce Bessemer steel."

The writer cannot say positively how large an area is covered by the float ore of the La Paloma, which gave the analysis introduced into this report, but it is his belief that it will cover 7,000,000 square feet, while the total absence of phosphorus indicates that this ore is much more valuable than that which was the subject of Mr. Birkinbine's examination.

There is no industry in Mexico which promises fairer returns than that of the manufacture of iron from these rich Mexican ores, and on this subject I will quote again from Mr. Birkinbine's report‡ the following table of prices of iron articles in Durango and the United States, together with the duty per pound in cents for importing them.

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* Ores thus marked contain above the limit of phosphorus previously allowed as the maximum in the purchase of foreign ores for Bessemer uses.

† This is for the 10,000,000 square feet; phosphorus 1.328 per cent.; for the 7,000,000 square feet 0.288 per cent.; and from the pig and bar iron from these ores 0.428 and 0.193 respectively. Mr. McCreath states that this result is lower than the average of our mill and forge irons, and the latter is "not excessive," in proof of which he gives analyses of standard English gun-tube irons four times worked.

‡ March 22d, 1882. These prices have altered somewhat, doubtless, since that date, but their relation to those of Monclova is probably unchanged.

Name of Article.	Durango Price per lb. Cents.	U. S. Price per lb. Cents.	Duty per pound. Cents.
Nails, ...	25 to 31	3½	5½
Spikes, ...	25	3½	5½
Horse shoe nails, ...	56	18 to 25	5½
Wagon springs, ...	37	10	5½
Bar iron, ...	13	3¼	2⅛
Sheet-iron, ...	20 to 24	3¼ to 6½	4½
Iron wire, ...	25 to 50	4 to 8	4½
Castings, ...	10 to 13	2½ to 4	1½
Window gratings, ...	18	4 to 5	13
Wood-stove (oval 12x18x30 in height),	$55 each	$10 each	8 c. per lb.

The Durango prices are not likely to differ in important respects from those at Monclova.

Mr. Birkinbine confirms the opinion of all competent observers who have recently been in Mexico as to the great and increasing need of manufactured articles of iron in that country. This need will increase in arithmetical progression for many years to come. He alludes to the possibility of the additional industry of tin-plating being added to that of iron manufacture on account of the occurrence of tin deposits in Durango. He mentions the articles most in demand in Mexico in the near future, as iron and steel-rails, frogs, wire, bar, plate, and sheet; spikes, nails, tin-plate, and castings, and machinery for mines and factories.

He recommends the erection of a plant consisting of a blast furnace, a small rolling mill, machine shops, foundry and smithery, and estimates their cost at $250,000 to $300,000. In his opinion the manufacture of pig-iron will not cost more in Durango than in the United States, and "with ample capital and good management" he "cannot see a doubt of success attending the establishment of a modern iron industry at Durango." As the official representative of one of the most important iron associations in the world, his testimony is of great weight, and what he has said of Durango is equally true of Monclova.

"RIOJAS."

This mine is situated in a mass of intrusive granite about four hours' walk southwestwardly from the *Paloma*, and not far from the Iglesia peaks, which border the broad plain, which stretches out at right-angles to the Monclova-Castaño plain, and near to the limestone-granite contact.

The vein, which is stained green by copper-salts, and includes a narrow seam of felsphathic gangue, is about two varas wide, and dips E. 10° S–85°. The pit is about the usual depth of ten varas, but no lead or silver ore was apparent either on the lower face or on the sides, though at first it was thought that specks of galeniferous ore were present. The opening was made along the strike N. 10° E.

At a depth of five varas, or half the depth of the shaft, there was a small spot in the hanging, in which it was thought that ore occurred. It was a copper-stained gangue, containing small particles of hard, black material, with metallic lustre. The patch, in which the mineral occurred, was not continuous above or below, and was altogether 2 or 3 inches broad.

The above observations were made in the main pit or shaft, which is the second, reached by a southwestwardly route from Monclova. A rough line was run hence N. 10° E. over a sharp, short ridge intervening between this and the first shaft, encountered on the route, and it seemed to establish the fact that these two shafts were sunk in the same vein, as the direction agreed with the strike, and signs of the outcrops were observed between the two. The distance between them is about ± 1500 feet, but the second shaft has fallen in, and, beyond a tradition that the Spaniards once worked it, nothing could be ascertained concerning it by the writer. Its depth is also unknown.

Still further north, but not on the strike of the Riojas vein, on the opposite side of a narrow cañon, is a long, deep cut, running about S. 30° W. for sixty feet. It is thought that this opening is on the Riojas vein, but this fact could not be established by the rough means available in a short visit, nor was anything further ascertained about this working.

The same may be said of a shaft to the south of the first opening described, which, however, seemed entirely off the line of strike of the vein, though this, too was indicated as an opening in the Riojas, but it was said that it had fallen shut, and it was not visited.

A small stream of water is found about a mile from the Riojas mine. The best route for the ore if mined in quantity would seem to be over the divide to the great transverse plain which separates the mountains in which the Riojas is situated (Cerro Mercado) from the Sierra de San Márcos.

The uncorrected barometer level of the mouth of the Riojas mine, above the ocean, is 3077 feet, or 1097 feet above Monclova, but the summit of the divide or the head of the Las Animas Cañon, is 4027 feet, so that the transportation, if in this direction, would involve a minimum distance of nine miles to Monclova, and an ascent of 950 feet.

"SAN RAFAEL."

Is situated on the north side of the Cañon del Real Viejo, in the Sierra San Márcos range, about nine Mexican leagues or twenty-three miles southwest of Monclova.

The metalliferous zone of which it forms a part, is also near a contact of limestone and granite, though wholly within the latter rock.

The road is from Monclova, nearly south to Castaño, a distance of eleven miles. From Castaño it deflects eastward through the fertile fortified Hacienda of Palo Blanco. Hence the trail is over the plain and into one of the cañons south by the spurs of this range. One of the valleys is called the Cañon de los Caballos, and this is the shorter route to the mine, but it is not chosen when camp is to be made, because its wide expanding wings concentrate the storm and rain winds, whereas the south wall of the Cañon del Real Viejo, immediately south of it, is a protection against the northers.

Castaño is 2462 above the sea by uncorrected barometer level, and Palo Blanco 2662, which would make the former 525 and the latter 725 feet above Monclova. The mouth of the Cañon del Real Viejo is 3155 feet above Palo Blanco, which is distant about nine miles. To this point, therefore, all the ordinary modes of transportation could be successfully applied. From here to the base of the steep ascent to the *San Rafael* Mine is 400 feet and the distance about ten miles. At this point the steep ascent to the north begins over a granite spur which appears soft and friable, like a weathered gneiss. At the base of this hill flows a small stream, which is said never to run entirely dry. Notwithstanding its small volume it would be of great value to the prosperity of any works erected here, as the portions of the range on the divide into the Real Viejo Cañon are destitute of water, like all the districts in limestone in this part of Mexico observed by me.

As just stated, the rock of the north boundary of the cañon is pulverulent and friable like a rotten gneiss. Many loose fragments of feldspar are observed. Many granite and feldspar and small quartz veins cutting the side of the hill are passed, and besides these, a dyke of syenite, south of the shaft, strikes N. 5° W., — vertical, and would intersect the *San Rafael* if continuous, near the deep shaft.

The first shaft passed on the vein is about 10 varas deep and is sunk on a whitish mass, striking N. 30° E., vertical or dipping slightly to the E. 30° S.

The deep shaft gives evidence of having been extensively wrought. The vein is two feet wide at the top or outcrop and exposes across its face bands of quartz and feldspar, of which the detached fragments frequently contain ore. At the surface the dip is E. 20° S.–85°. A short distance down the slope the vein changes to E. 40° S.–80°, and at a depth of 20 varas it changes to a vertical dip, widening also somewhat. Its strike is N. 35° E. and its breadth about one vara, or 33.38 inches.

The opening was in a very dangerous condition, and there are at present four victims of the culpable carelessness of somebody, who lie buried at the bottom of the shaft where they were crushed seven years ago. The slopes have been irregularly made, and have been left without timbering of any kind. In time the granite, which has been very much fractured, has partially detached large blocks from the sides and roof; and the whole excavation is thus lined to the base of the last shaft.

A very slight shock would bring down one or more of these and effectually seal the opening against all efforts to escape. The writer examined this mine to the depth of about 20 varas.

The vein matter is a weathered feldspathic granite which is said to be poor down to a level which by a singular coincidence corresponds with the present bottom of the mine. This statement cannot be now verified, but has not any reason that the writer could see to support it. Specimens taken by him from the surface outcroppings of the vein had an average specific gravity of 2.46, and on assaying were found to contain $15.48 in silver and no lead (as might have been anticipated from the low specific gravity).

There are altogether six shafts on this vein averaging 8 varas in depth and about 10 varas apart, but none of them were in a condition to examine, except the deep shaft above considered.

A narrow seam of very feldspathic granite lies on the hanging of this shaft. It is ¾ inch thick, and is said always to mark the surface of this wall in the deep, though it is also said to thicken very much there.

About six inches from the hanging, a vein of *guija* (gangue), is noticed to carry ore.

The mountain facing this ore and on the north side of the cañon, is a limestone mountain, as also that which faces it to the north across the cañon of the Caballos. Both these cañons are, therefore, depressions caused by contact of intrusive granite and limestone. The road up the Cañon de los Caballos is the shorter but much the rougher of the two. The ores, if free milling ores, could be treated with advantage near the mouth of the ravine, and the bullion transported through either of these cañons to the market.

In the cañon are numerous ruins of old works (some of Spanish origin), including one for the treatment of the ores which was only abandoned a few years ago.

This locality has all the elements of a region rich in mineral veins. That is to say, the presence of this great granite mass in the midst of the limestones, and the existence of the many dykes which have cut through it, have furnished conditions which are favorable to the deposition of metalliferous matter. But it is not necessary to speculate inductively on this subject. The depth to which this mine has been wrought; the many other mines in the neighborhood which were once wrought by the Spaniards; and more than all, the extensive mining enterprises being conducted in the Potrillo, just over the divide, and within a mile or two of this place, all point to it as one where the probabilities of mineral wealth are very strong.

In the table on the next page I have endeavored to condense as much as possible the scientific and economical data which have resulted from the examination of these ores. In this table, the first column comprises the samples so marked as to indicate whether collected by the writer or simply given to him and collected by some one else. Under the head of SILVER the values per ton are given, both at the rate at which silver was selling in January, 1884, and also on the less commendable but more usual calculation of the "coin value," or that value which is ascribed to silver in the coinage, on the supposition that the copper alloyed with it has no value and the silver alone is worth the denomination of the coin. The lead has been calculated in per cent. and afterwards at the ruling price at the same epoch. Finally, the sum of the two values is given in the next to the last column, and the specific gravities in the last column.

Some values have been suppressed for reasons connected with the business interests of the Company which desired this investigation to be made.

Mexican Ores, analyzed in the Laboratory of Dr. Persifor Frazer, of Philadelphia, by Mr. C. Hanford Henderson.

Ores marked with (*) were collected by Dr. Frazer. Ores marked with (†) were furnished by other persons.

		SILVER PER TON.			LEAD.		Total Value per ton, 2000 lbs. Lead and Silver (1.29).	Sp. Gr.
		Ounces.	Value, $1.10 per oz.	Value, $1.29 per oz.	Per cent.	Value per ton, @ 4.35 cts.		
*	1. Arroyo Mine. Average across heading,	trace		....	6.59	$5 73	$5 73	3.20
*	2. Arroyo Mine. Pay dirt, selected by P. Roblez,	15	$16 50	$19 35	21.31	18 54	37 89	
†	3. Arroyo Mine,	23	25 30	29 67	40.25	35 02	64 69	
†	4. Arroyo Mine,	33.5	36 85	43 22	43.14	37 53	80 75	
*	5. Minas Viejas Red ore of *Buena Vista* opening,	2.5	2 75	3 23	9.2	8 00	11 23	3.31
*	6. Montaños Mine. Specimens from various faces,	8	8 80	10 32	53.89	46 88	57 20	4.52
*	7. Montaños Mine. Average, *Boca Nueva*,	4.5	4 95	5 81	50.88	44 27	50·08	
†	8. Montaños Mine,	2.5	2 75	3 23	47.95	41 72	44 95	
†	9. Montaños Mine,	2	2 20	2 58	57.25	49 81	52 39	
*	10. Pinitos. Average of main vein,	24	26 40	30 96	21.9	19 05	50 01	3.90
*	11. Pinitos. South branch of south opening,	2	2 20	2 58	5.92	5 15	7 73	
*	12. Pinitos. Gangue mass in face of drift,	1	1 10	1 29	0	....	1 29	
†	13. Pinitos. ["Panetious No. 2"],	45.6	50 16	58 82	31.24	27 18	86 00	
†	14. Pinitos. Ore from No. 2 opening,	330.2	363 22	425 96	60.1	52 29	478 25	
†	15. Pinitos. ["Dirt out of Panetious main opening"],	849.8	934 78	1096 24	46.11	40 12	1136 36	
†	16. Pinitos. "Dirt," No. 1,	55.5	61 05	71 60	51.36	44 68	116 28	
†	17. Pinitos. "Coarse," No. 1,	53	58 30	68 37	42.87	37 30	105 67	
†	18. Pinitos. "Fine," No. 1,	145.5	160 05	187 70	42.66	37 11	224 81	
†	19. Pinitos. "Uncobbed fragments," No. 2,	43.5	47 85	56 12	35.11	30 55	86 67	
*	20. Riojas Mine. Bottom of shaft,	....	....	....	....	....	....	3.24
*	21. Riojas Mine. From Mr. Day,	....	....	....	....	....	....	
*	22. Riojas Mine. From Mr. Hartz,	....	....	....	....	....	....	
†	23. Riojas Mine,	29	31 90	37 41	61.21	53 25	90 66	
†	24. Riojas Mine,	527	579 70	679 83	65.32	56 83	736 66	
*	25. San Rafael. 10 varas from surface,	....	....	....	....	....	....	
*	26. San Rafael. Across outcrop,	12	13 20	15 48	....	....	15 48	2.46
*	27. San Rafael. 60 varas deep,	....	....	....	....	....	....	
†	28. San Rafael. "Metal,"	75.2	82 72	97 00	trace	....	97 00	
†	29. San Rafael. Main opening,	304.2	334 62	392 42	48.27	41 99	434 41	
†	30. San Rafael,	1	1 10	1 29	38.74	33 70	34 99	

MILL SITE NEAR MONCLOVA.*

An examination was made of a fine mill-site, two and a half miles southeast of the town of Monclova, known as the Campañas. The river Monclova, which flows through the town of that name, separates into several branches at the Campañas and reunites further down the stream. After following the stream up the current from Monclova, one soon passes into a valley bounded by low narrow ridges of conglomerate, containing pebbles of the carboniferous limestone of the Sierra de la Gloria and the Cerro Mercado. These hills separate more widely towards the head of the Campañas, and, finally, after sweeping around a flat and fertile meadow of five or six acres, run directly across the course of the stream, forming a waterfall and rapids of sixty-five feet.

A very rough experiment, made with a view of testing the volume of the portion of the stream which forms the falls on the Monclova side of the river, gave 21,000 gallons a minute.

This would furnish ample power for a stamp-mill, dressing-works, and compressed air for a blast furnace; and, if more power were necessary, about three times as much could be obtained by employing the whole stream instead of the portion of it which has been mentioned.

The situation has not escaped the observation of enterprising men in the past. A large cotton mill was erected here by an Englishman, and worked with profit for some time, until its final destruction by fire.

The cliff over which the stream plunges is the same conglomerate, of which the upper part is decomposed into earth and pebbles, the latter being rolled fragments of the limestone of the great ranges of the Sierras de la Gloria and San Márcos. A vein of highly ferruginous matter about 3 varas in thickness crosses the conglomerate, striking about S. 20° W.

FUEL.

A most important element of success in any undertaking to work the mines previously described, is the question of fuel.

At present the charcoal made from the Mesquite and other trees of the region, has sufficed to supply this demand; but in spite of the fact that some of this charcoal is quite compact and tenacious, it will soon cease to be available except in abnormally favored regions, because tree-growth is not a strong feature of this region, and most of the plants which replace it have not that woody fibre which is best suited to make good charcoal; and even in the opposite case it is hardly doubtful that good coke would be a better material.

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* See Plate 7.

In discussing the subject of fuels in the report quoted above, Mr. Birkinbine says of the Durango ore that it would not be advisable to construct an ironworks at that locality, dependent on mineral coal or coke for fuel, but that the railroads will soon establish a communication with coal deposits. Further on, he states the cost of charcoal (made from the Mesquit and Huysachic woods, either of which he adds makes a hard dense charcoal which possesses unusual calorific power) as 8 to 10 cents a bushel which "could be much reduced if more modern practice was employed, and large quantities produced."

Without discussing the question with Mr. Birkinbine of what species of fuel will ultimately prove most advantageous to the Mexican iron industry, it may be remarked that his suggestions are well worthy of attention.

Monclova is about seventy miles southwest of the extensive coal fields opened up by Dr. H. B. Butcher.

The communication is by the Hermanos Pass, and there would probably be but little difficulty in running a narrow gauge road by the Rio Salada, and through Progreso (provided no nearer coal fields be opened), to connect the mines and Monclova, which is destined in any event to be a commercial and manufacturing centre of great importance.

In this connection the practice at the Pánuco smelter at Candela, is quite interesting. These furnaces have been conducted by Dr. Henry B. Butcher, and have been run on the coal which he first discovered near the river Sabinas (?) twenty miles north of Progreso.*

Dr. H. B. Butcher informs me that the reverberatory (Swansea) furnaces were capable of treating four charges of 1½ to 2 tons of the Pánuco copper ore in a day, and that to do this, required from 3 to 3½ tons of coal. The total amount of ore would thus be 6 to 8 tons, and the limestone mixed with it from 120 pounds to 200 pounds. In other words, from 12,120 pounds to 16,200 pounds of charge was treated by 6000 to 7000 pounds of coal, which shows very well for its duty on the large scale. An inspection of the residue left under the grate revealed numerous fragments of well-coked coal, which was coherent and well adapted to metallurgical operations.

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* This locality is marked in the specimens of fossils which he was good enough to give me "Sabinas," though on his map the coal mine occurs on a river marked "Rio Sa" which is seen to form a junction with a stream called the "Salada."

I selected some of the coal from the bins at the furnace, and had it analyzed in my laboratory by Mr. Henderson, with the following results:

Specific gravity of coal,	1.46	
Hygroscopic moisture,		.54
Volatile combustible matter,		19.26
Fixed Carbon (Coke), by difference,		62.32
Ash (light grayish white),		17.88
Total,		100.00
Fuel ratio,	3.23	

The following check analysis was subsequently made by Mr. Richard D. Baker of another fragment of the same piece of coal.

As the two analyses were fragments and not from an *averaged* lot, the differences are unimportant.

The lesser percentage of volatile combustible matter in the following analysis may be due to changes which had taken place in the coal itself during the two weeks of its exposure in the laboratory intervening between the two analyses:

Hygroscopic moisture,		51	
Volatile combustible matter,		18.76	
Fixed Carbon (Coke) by difference,		65.35	
Ash (light grayish white),		15.38	
		100 00	
Sulphur,			0.317
Phosphorus,			trace.
Fuel ratio,	3.48		

It may be interesting to compare this result with that obtained from a specimen of coal from the Carazal, which was furnished by Mr. W. A. Butcher, and analyzed by Mr. Henderson.

Specific gravity of coal,	1.39	
Hygroscopic moisture,		0.58
Volatile combustible matter,		16.24
Fixed Carbon (Coke), by difference,		64.48
Ash (grayish white),		18.70
Total,		100.00
Fuel ratio,	3.97	

The fuel ratios, or the ratio between the solid and volatile hydrocarbons are 3.23, 3.48, and 3.97 which place them well within those of bituminous coals, *i.e.*, those having a fuel ratio of from 5 to 0.

It will be understood by all those familiar with coals, that the large percentage of ash in the above analyses is a variable factor which is almost certain to be very much reduced when the mines get to producing on the large scale. The fuel ratio was a means suggested by the author, to ascertain the true relationships of the coal independent of this fortuitous factor.*

It is, of course, of the greatest importance that in the great development which Mexico is almost certain to undergo in the next few years, that fuel, the most important adjunct to such development should be obtainable from her own domain, and near the scenes of the operations which foreign capital is about to commence.

LIST OF LEVELS OBTAINED FROM MR. E. A. HANDY, ENGINEER IN CHARGE "MEXICAN NATIONAL R.R.," SALTILLO, MEXICO.

	Feet above ocean level.
Laredo, Texas,	**438**
Lampasos, Mexico,	**1032**
Villaldama, "	**1412**
Monterey, "	**1790**
Garcia, "	**2334**
Saltillo, "	**5253**
Puerta de los Carneros, Mexico,	**6916**
Matehuala, "	**5360**
Solis, "	**6138**
Monclova, "	**1980**
Monclova,† "	**1948.85**
Castaño,† "	**2431.14**

THE CORRECTED BAROMETER LEVELS BASED UPON THE ABOVE DATA. TAKEN BY THE WRITER IN MEXICO, NOVEMBER AND DECEMBER, 1883.

	FEET ABOVE SEA		FEET ABOVE SEA
Laredo (Texas),	**438**	Bridge over Salado,	558
Bridge over Rio Grande (?),	518	Mojino (station M. N. R.R.),	733
Nuevo Laredo, Mexico,	568	**Lampasos,**	**1032**
First cut west on railroad,	633	Golondrina (station N. M. R.R.),	1407

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* See Proceedings of Am. Inst. of M. E., vol. vi., p. 430, and Publication of the 2d Geol. Surv. of Pa., vol. M., p. 128.

† Data obtained from the Mexican International R. R.

	FEET ABOVE SEA
Guadalupe (station N. M. R.R.),	1462
Pass through foot-hills west,	1637
Second Mescal Ranche,	1812
Piedras Pintas,	1987
Near foot of Yguana Range,	2612
Cedar Tree (at Candela Fork),	3212
Later,	3837
10 minutes later,	4152
15 minutes later (summit),	4462
8 minutes later (commencement of descent),	4462
14 minutes later (foot of steep descent),	4212
Jacal M. Viej (15 minutes later),	4062
Boca Negra,	4337
Mouth of "Buena Vista" drift,	3897
"Doctor,"	3797
"Guadalupe Mine,"	3517
Boundary of *Arroyo* (*S. of Claim*),	3497
Mouth of *Arroyo* Mine,	3342
Near bound. of *A.*, head of gulch,	3437
Villaldama Station,	**1412**
Villaldama (Botello's),	1372
In Villaldama Valley,	1747
Jacal d. San Isidro del Portrero,	1822
Mouth of Portrero Cañon,	1917
100 yards east of the following:	2697
San Antonio,	2722
Jacal de Don Tomas Gonzalez Villareal,	2747
45 minutes on road to Pinitos,	3642
Estacado (halting place),	3742
15 minutes from above,	4492
Encino Gordo (second halting place),	4607
Pinitos main opening,	5317
Botello's jacal,	6067
1st halt on road to *Montaños*,	6267
2d halt on road to *Montaños*,	6317
Water hole nearest jacal,	6367
Minor summit on range (road to *Montaños*),	6387
Vein, outcrop on route,	6342
Summit on route to *Montaños*,	6567
Principal mouth of *Montaños*,	6017
Summit, 3 hours later, 12.45 P.M.,	6567
25 minutes later, Botello's jacal, 1.10 P.M.,	6067
Hacienda San Anton. (foot of field),	2672
Lampazos town (Vasquez's shop),	1092
El Paso Creek (road to Candela),	1132
Candela (Dr. H. M. Butcher's house),	1012
Candela (copper furnaces),	1612
Entrance to Puerto,	1767
Middle of Puerto,	1882
Ojos Calientes,	1872
Puerto San Antonio,	2252
Road crossing ridge east of Pánuco,	2752
House at Pánuco Mine,	3742
Mouth of Graham Level,	4017
Tree near gold mine, in bed of brook,	3927
Gold Mine (of W. A. Butcher),	3977
Summit between Gold Mine and Pánuco,	4377
Road from Pánuco Mine, at Second Arroyo,	3077
Intersection with main road to Monclova,	2217
Ranche del Salitrillo,	1937
Hacienda de la Mota,	1937
Carizo Lejos,	1727
Hacienda de El Oro,	1877
San José,	1917
Jim. Denning's (Monclova),	1937
Monclova (Point unknown R.R datum),	**1980**
Monclova,*	**1948.85**
Head of Campañas,	2025
Bottom of hill,	1972
Foot-hills, 5 miles southwest of Monclova,	2427
Opening of Iron Mine,	2577
Ridge between cut and *Riojas*,	3627
Summit of Divide Las Animas Cañon,	4027
Water line Las Animas Cañon,	3427
Iron outcrops, Trail to Riojas,	3252
Mouth of Riojas (second shaft),	3077
Dump pile (first shaft Riojas),	3027
Road to Saltillo, opposite iron mine,	2187
Castaño,	2462
Castaño,*	**2431.14**
Palo Blanco (Coahuila),	2662
Camp. Cañon del Real Viejo,	3337
Water line below *San Rafael*,	3737
Mouth of first shaft *San Rafael*,	4437
Mouth of principal shaft *San Rafael*,	4512
Another point (foot of steep hill),	3787
Camp, near above,	1927
San Ramon,	1952
Highest point opposite Sierra Colorada,	1902
Dinner Camp,	1842
Bustamante Station,	1532
Palo Blanco Station,	1887
Salinas Station,	1547
Monterey Station,	**1790**
Monterey hotel,	1465

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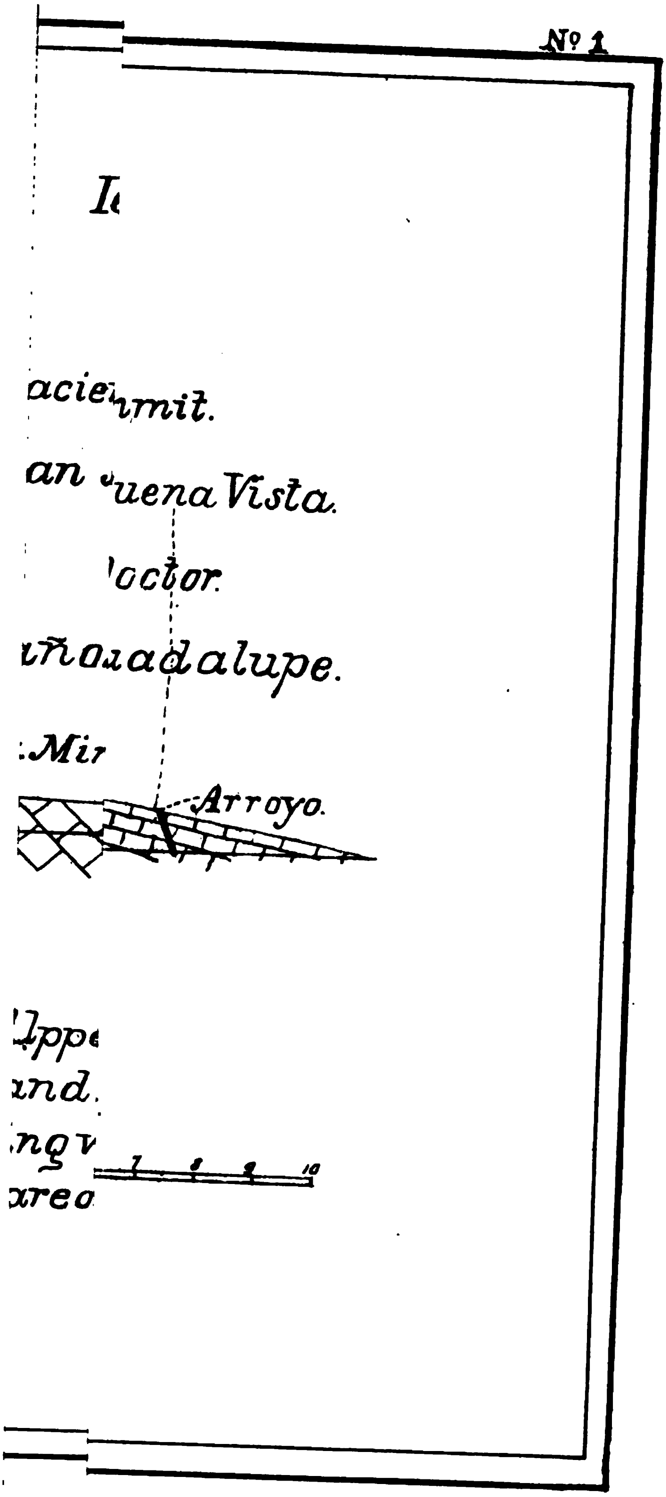
* Data obtained from the Mexican International R. R.

Amidst many conflicting data, unavoidable in a case like the present, where a large number of observations extending over a long time were made on a single aneroid barometer without even the check which simultaneous readings of a stationary instrument would have supplied, the height of Guadalupe station was assumed as 430 feet above Lampazos station, this being the mean of two sets of readings taken at intervals of two hours between the stations. This makes Guadalupe station 1462 feet above ocean level, and all the altitudes in the Villaldama district are calculated on this basis. The altitudes obtained in the Monclova district, and in the region between it and Lampazos, are calculated directly from the datum of Lampazos station. The isolated datum for Monclova obtained from Mr. Handy could not be used because the exact spot is not specified.

Nº 1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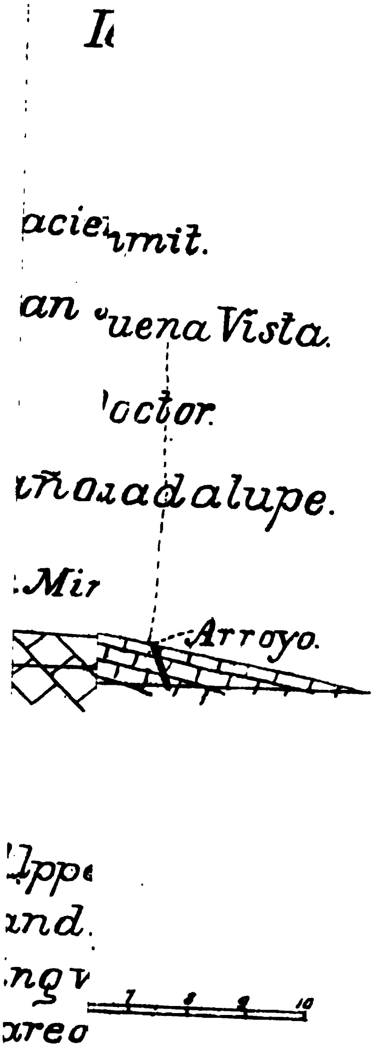

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